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The principal metallic mineral of the sulphide ore is chalcocite, and the average tenor of the ore thus far mined by the Ray Consolidated, 1.7 per cent copper. The average tenor of the ore sent to the Inspiration mill in 1916 was about 1.55 per cent copper.

The oxidized material is of two kinds. The first carries chrysocolla, azurite, and malachite, and is in part rich enough to ship to the smelter. Such material is relatively little iron-stained and is formed by the encroachment of oxidation in nearly pure chalcocite ore. The second type of oxidized material is leached of copper; it is *not* stained blue or green, but is mostly reddish from iron oxide. It is formed by the oxidation of material carrying considerable pyrite. No criteria were developed for recognizing capping over rich ore bodies beyond the observation that very red capping is likely to overlie protore or thin, highly pyritic ore. Assays of this sort of capping show from a trace to 0.2 per cent copper. The average thickness of the oxidized zone at Ray is 250 feet (range 45 to 600 feet).

The lower limit of oxidation and the position of the ground-water level at the time mining began were far from coincident, the divergence being particularly striking at Miami. Drill holes show that enriched ore lies partly above and partly below that water level. This suggests that enrichment was related, in important measure, to an earlier topography. This conclusion is supported by evidence which shows that much faulting has occurred subsequent to enrichment bringing oxidized and leached material in some places in lateral contact with rich ore on the same level. Rounded fragments of crushed chalcocite ore and fragments of oxidized material are found in the gouges of a number of these faults. The Pleistocene (?) Gila conglomerate appears to have been deposited subsequent to most of the enrichment, for the ores lie deepest in fault blocks capped by this conglomerate.

The deposition of the protores is attributed to thermal solutions coming from deep-lying portions of the granite-porphyry magmas, probably in early Tertiary times.

E. S. B. AND C. H. B.

Gypsum Deposits of the United States. By R. W. STONE. U.S. Geological Survey, Bull. No. 697, 1920.

This bulletin was prepared to take the place of Bulletin No. 223 published in 1904, on the same subject. Since that time (to 1918) the production of gypsum has increased more than 300 per cent. In 1918 the production was valued at $11,000,000.

Gypsum deposits are classified according to origin, mode of occurrence, relation to the earth's surface, etc.

According to mode of occurrence there are the following classes: (1) Interbedded deposits alternating with shales, limestones, and sandstones, laid down in seas or lakes. (2) Efflorescent deposits due to evaporation of water which has come to the earth's surface through gypsum deposits. The result is gypsite, a finely crystalline form of gypsum. (3) Periodic lake deposits due to deposition of gypsum from the waters of intermittent lakes. These are granular and crystalline, and vary much in size. (4) Gypsum veins due to re-working of deposits of the bedded type by ground water, and redeposition in veins. The deposits are crystalline, occurring as satinspar or selenite. (5) Gypsum dunes due to disintegration of massive gypsum or efflorescent deposits, and their transport by the wind. (6) Isoltate crystals and flakes due to formation of sulphuric acid from pyrite and the reaction of the latter on limestone.

According to origin the deposits are classified as: (1) surface-water deposits; (2) ground-water deposits.

In age gypsum deposits vary from Silurian to Quaternary. In 1918 gypsum was produced in eighteen states and in Alaska. New York was the largest producer, Iowa second, and Michigan third.

In New York gypsum has been mined more than one hundred years, during which time it is estimated that about ten million tons have been produced. The deposits are in the Salina (Silurian) formation. The gypsum is in a series of lenses and was deposited by evaporation from an inland sea. The future of the industry in this region is difficult to predict, since the gypsum beds run under younger rocks to the south and the distance they can be profitably mined is uncertain.

In Iowa there are two areas of gypsum, the area around Fort Dodge being the more important. Here the gypsum occurs in bedded deposits which overlie the Mississippian and Pennsylvanian unconformably. They are thought possibly to be Permian. These beds have been worked since 1872. At Centerville gypsum was discovered a few years ago at a depth of 500 feet, but is not yet developed. At this place the gypsum is in limestone of Mississippian age.

In Michigan the deposits are in the Michigan formation of the Mississippian system, and in the Bass Islands formation, and Salina formation of the Silurian. The gypsum is of the massive rock variety, and constitutes lenses in shale and limestone. The deposits are almost inexhaustible. The chief development is in the central part of the southern peninsula at Grand Rapids, and north of Saginaw.

In the west production of gypsum is not very great, but a number of states, especially Oklahoma, Wyoming, Utah, Nevada, California, and New Mexico have large reserves. The Wyoming deposits are found in the Embar (Permian), Chugwater (Permian or Triassic), and Spearfish (Triassic) formations. The deposits are in the Red Beds.

In California the most promising deposits are south of San Francisco Bay, associated with Tertiary and Pleistocene formations. The most valuable are of the gypsite variety. Many of them lie on the side of knobs or ridges. The deposits are due to the ground water being drawn to the surface and evaporating, leaving behind its load of gypsum acquired from the underlying rocks. There are two other forms of deposits in the California districts, intermittent lake deposits and interbedded deposits.

In New Mexico there are large deposits of gypsum which have been developed but little. They occur as bedded deposits in the Manzana group of the Pennsylvanian and in the Wingate Sandstone of the Jurassic. In the top of the latter there is a bed 100 feet thick. Gypsum also occurs as surface crusts due to evaporation at the surface, and as dunes, the material being derived from such crusts. The dunes are in the Tulurosa Desert and cover an area of 270 square miles. The gypsum from the dunes is used to a slight extent.

F. P. S.

Geology of Webster County and a Portion of Mingo District, Randolph County, South of Valley Fork of Elk River. By David B. Beger. West Virginia Geological Survey, 1920. Pp. 682, pls. 35, figs. 24, maps 2.

Webster County lies in the Cumberland Plateau, the westernmost division of the Appalachian province. The topography is characterized by deep valleys cut into an old peneplain, the relief varying from 500 to 1,000 feet. The structure is a gently southeastward dipping monocline with some minor folds. The stratigraphic range includes beds of the Upper Mississippian and Pennsylvanian. The Allegheny, and the Kanawha and New River groups of the Pottsville, form the greater part of the surface outcrops, the Monongahela having been entirely stripped off and the Conemaugh mostly. Mississippian formations, represented by the Mauch Chunk shales, of continental origin, and the Green Brier limestone, outcrop only in some of the deeper valleys of the county and in the included portion of Randolph County. The latter is remarkable for its profusion of marine forms. Devonian beds are known only from deep-well records.